(12) UK Patent Application (19) GB (11) 2 319 127 (13) A

(43) Date of A Publication 13.05.1998

(21) Application No 9720799.7

(22) Date of Filing 30.09.1997

(30) Priority Data
(31) 96043267 (32) 30.09.1996 (33) KR

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(51) INT CL^6
H03M 1/54

(52) UK CL (Edition P)
H3H HAP
U1S S2124

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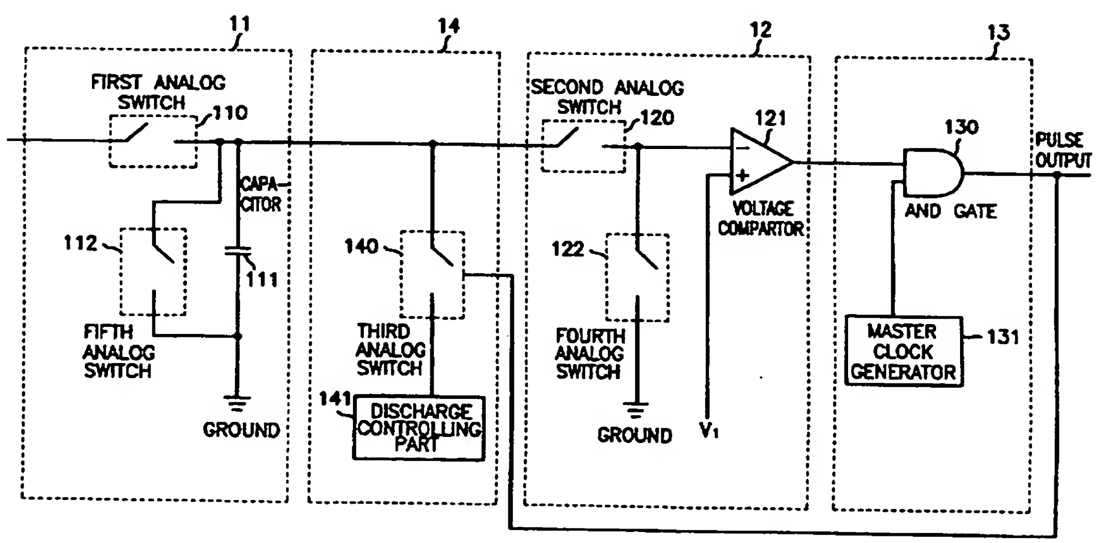
(58) Field of Search
UK CL (Edition P) H3H HAP
INT CL^6 H03M 1/00 1/12 1/50 1/52 1/54
Online:WPI

(54) **Voltage/pulse converting apparatus**

(57) Apparatus for converting a voltage into pulses has a charging part 11 receiving the voltage, a voltage comparing part 12 for comparing the output voltage from the charging part 11 with a reference voltage value, a pulse extracting part 13 for outputting pulses in response to the comparison result; and a discharging part 14 for discharging the charge in the charging part 11 in response to the output signal of the pulse extracting part 13 or the comparing part 12.

FIG. 2a



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This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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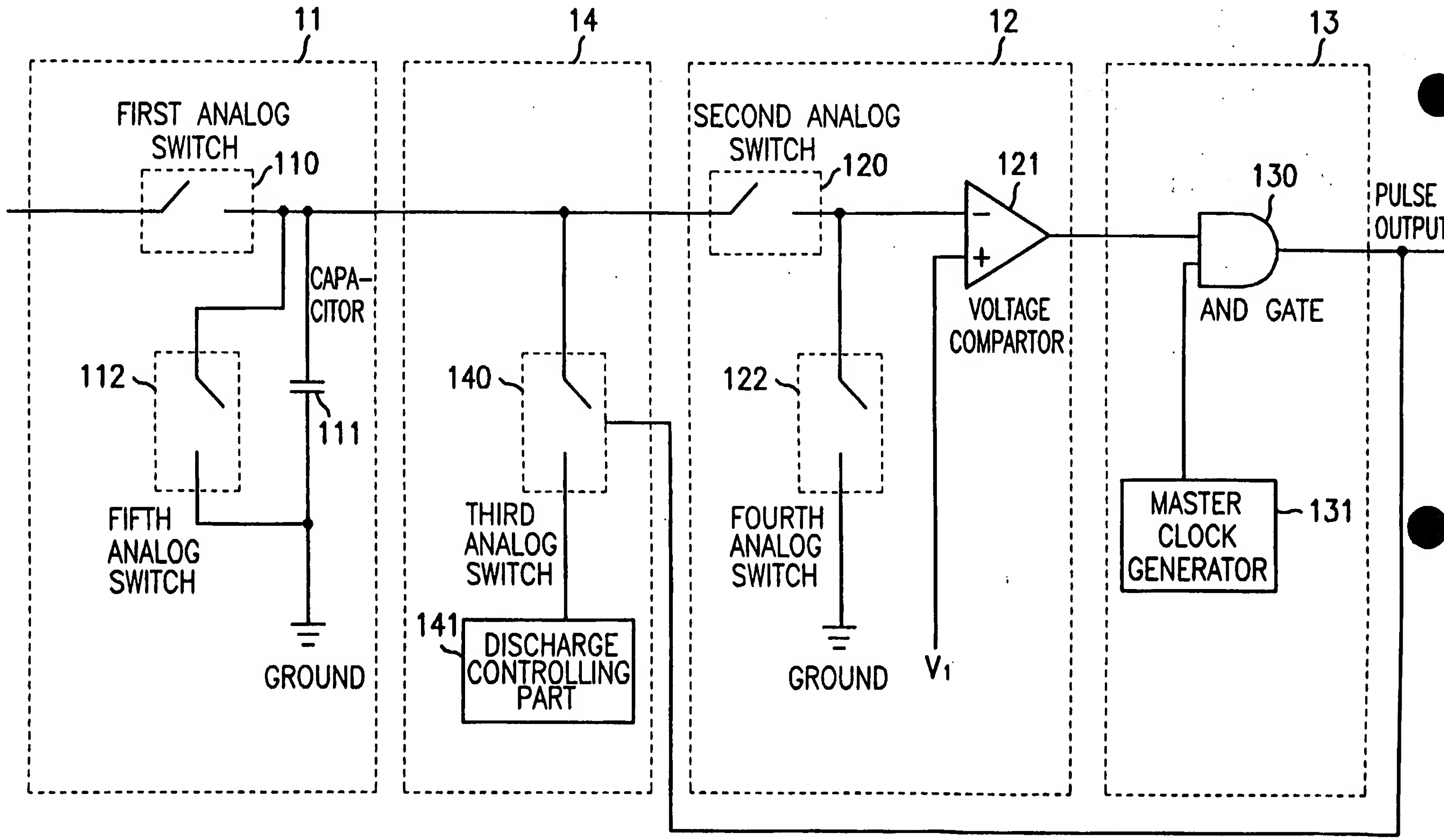
FIG. 2a


11
14
12
13
FIRST ANALOG SWITCH
110
CAPA-CITOR
111
112
FIFTH ANALOG SWITCH
GROUND
140
THIRD ANALOG SWITCH
141
DISCHARGE CONTROLLING PART
SECOND ANALOG SWITCH
120
122
FOURTH ANALOG SWITCH
GROUND
121
VOLTAGE COMPARTOR
V_1
130
AND GATE
MASTER CLOCK GENERATOR
131
PULSE OUTPUT

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A VOLTAGE/PULSE CONVERTING APPARATUS

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to a voltage/pulse converting apparatus, more specifically relates to a voltage/pulse converting apparatus which changes pulses in response to voltage variations for analog signal processing or for analog digital hybrid signal processing.

Description of the Prior Art

A general voltage/pulse converter continues to generate identical pulse if the voltage value is lager than a threshold, or discontinues to generate pulse if the voltage value is less than or equal to the threshold. Therefore, it is generally used for generating pulses such like carrier frequencies in communication fields.

A conventional calculator in the signal processing apparatus such like a neural network computer has a problem that its operation speed is low because it performs computing process after changing analog voltage value to digital value by using analog/digital(A/D) converters.

Also, since the A/D converter has a large size, when the voltage/pulse converter used in the neural network computer is implemented by using A/D converters, then there are problems in

chip integration and a manufacturing process.

Therefore, for neural network computer, a new voltage/pulse converter is needed.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to a voltage/pulse converting apparatus which performs rapid analog operations by using voltage variations for analog signal processing or for analog digital hybrid signal processing.

In accordance with one embodiment of the present invention, this object is accomplished by providing a voltage/pulse converting apparatus comprising: a charging means for charging current inputted from outside; a voltage comparing means for comparing the output voltage from said charging means with a reference voltage value, and for outputting comparison result; a pulse extracting means for generating and outputting pulses in response to said comparison result; and a discharging means for discharging said current through said charging means in response to said output signal of said pulse extracting means.

In accordance with another embodiment of the present invention, this object is accomplished by providing a voltage/pulse converting apparatus comprising: a charging part for charging current inputted from outside; a voltage comparing part for comparing the output voltage from said charging part with a reference voltage value, and for outputting comparison result; a pulse extracting part for generating and outputting pulses in

response to said comparison result; and a discharging part for discharging said current through said charging part in response to said output signal of said voltage comparing part.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and aspects of the invention will become apparent from the following description of the embodiments with reference to the accompanying drawings in which:

Fig. 1A is a block diagram of a voltage/pulse converter in accordance with the first embodiment of the present invention;

Fig. 1B is a block diagram of a voltage/pulse converter in accordance with the second embodiment of the present invention;

Fig.2A is a diagram illustrating a detailed circuit of a voltage/pulse converter in accordance with the first embodiment of the present invention;

Fig.2B is a diagram illustrating a detailed circuit of a voltage/pulse converter in accordance with the second embodiment of the present invention;

Fig.3A is a diagram illustrating a detailed circuit of a discharging part in accordance with the first embodiment of the present invention;

Fig.3B is a diagram illustrating a detailed circuit of a discharging part in accordance with the second embodiment of the present invention;

Fig.4A is a diagram illustrating a detailed circuit of another discharging part in accordance with the first embodiment of the

present invention;

Fig.4B is a diagram illustrating a detailed circuit of another discharging part in accordance with the second embodiment of the present invention;

Fig.5A is a diagram illustrating a detailed circuit of another discharging part in accordance with the first embodiment of the present invention;

Fig.5B is a diagram illustrating a detailed circuit of another discharging part in accordance with the second embodiment of the present invention;

Fig.6 is a diagram illustrating a detailed circuit of a voltage comparator in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments of the present invention will be described with reference to the accompanying drawings.

Fig. 1A illustrates a block diagram of a voltage/pulse converter in accordance with the first embodiment of the present invention, and Fig. 1B illustrates a block diagram of a voltage/pulse converter in accordance with the second embodiment of the presentinvention. Fig.2A is a diagram illustrating a detailed circuit of a voltage/pulse converter in accordance with the first embodiment of the present invention, and Fig.2B is a diagram illustrating a detailed circuit of a voltage/pulse converter in accordance with the second embodiment of the present invention.

In Fig.1A through 2B, the reference numeral 11 designates a

charging part, 12 a voltage comparing part, 13 a pulse extracting part, and 14 a discharging part.

First, the first embodiment of the present invention will be described with reference to Fig.1A and Fig.2A.

The charging part 11 consists of two switches and a capacitor. In the charging part 11, if a first analog switch 110 turns on, then the current are inputted from outside and charges are accumulated on the capacitor 111. Therefore, voltage of a capacitor 111 increases. Also, a fifth analog switch 112 is made to be coupled to the capacitor 111 in parallel to eliminate the charges which are lower than the reference voltage and are remained in the charging part 11. In other words, the fifth analog switch 112 for reset of voltage/pulse converter is coupled to the capacitor in parallel with capacitor 111.

The voltage comparing part 12 consists of two analog switches and a voltage comparator. When the first analog switch 110 turns on, a second analog switch 120 is made to turns off, and a fourth analog switch 122 is made to turns on, whichby the voltage comparing part 12 is reset. For a substantial operation of the voltage comparing part 12, no more current are inputted into the charging part 11 by making the first switch 110 turn off. If the second switch 120 is made to turn on, and simultaneosly the fourth switch 122 is made to turn off, then an output of the voltage comparing part 121 turns on when voltage of the capacitor 111 is higher than the reference voltage V_1, and an output of the voltage comparing part 121 turns off when voltage of the capacitor 111 is

lower than the reference voltage V_1.

The pulse extracting part 13 consists of two input logical AND gate 130 of which one input is coupled to the output of the voltage comparing part 12 and the other input is coupled to a master clock generator 131. If the output of the voltage comparing part 12 turns on, pulses are continuously generated at a master clock cycle and outputted to the output terminal of the pulse extracting part 13, and if it turns off, no more pulse is generated.

The discharging part 14 comprises an analog switch 140 and a discharge controlling part 141. If the output signal of the pulse extracting part 13 turns on, the output pulse of the pulse extracting part 13 is returned back to the discharging part 14 as a on/off control signal of the discharging part 14. If the third analog switch 140 turns on, then the capacitor 111 is coupled to the discharge controlling part 141, and the current through the capacitor 111 is discharged. At this time, the current through the capacitor 111 is discharged through the discharge controlling part 141. A resistant element(is an element having resistant value for controlling a current discharge rate) or a constant-current element(is an element making the current through the capacitor outputted at a constant rate) is used as a discharge controlling part 141. Fig.3A, 3B, 4A and 4B are block diagrams illustrating the discharge controlling part 141 by using the resistant elements, and Fig.5A and 5B are block diagrams illustrating the discharge controlling part 141 by using the constant-current elements.

In the voltage/pulse converter as described above, all

switches except for the third analog switch 140 in the discharging part 14 may to be turn on/off in response to a control signal from an external processor.

Next, the second embodiment of the present invention will be described with reference to Fig.1B and Fig.2B. Most configuration and operation of the circuit are identical to the first embodiment except for the several point to be described below.

If an output signal of the voltage comparing part 12 is on state, the output signal is returned back to the third analog switch 140 in the discharging part 14, and the third analog switch turns on, which the capacitor 111 is coupled to the discharge controlling part 141. The current through the capacitor 111 is discharged through the discharge controlling part 141.

Fig.3A illustrates a detailed circuit of a discharging part in accordance with the first embodiment of the present invention, and Fig.3B illustrates a detailed circuit of a discharging part in accordance with the second embodiment of the present invention. Fig.4A illustrates a detailed circuit of another discharging part in accordance with the first embodiment of the present invention, and Fig.4B illustrates a detailed circuit of another discharging part in accordance with the second embodiment of the present invention. Fig.5A illustrates a detailed circuit of another discharging part in accordance with the first embodiment of the present invention, and Fig.5B illustrates a detailed circuit of another discharging part in accordance with the second embodiment of the present invention. Fig.6 illustrates a detailed circuit of

a voltage comparator in accordance with the present invention.

The operation of circuits in accordance with the present invention will be described.

When the first analog switch 110 turns on, the current from the outside is accumulated on the capacitor 111 in the charging part 11, such that voltage of the capacitor increase. At this time, the second analog switch 120 turns off, the fourth analog switch turns on, and the state of the voltage comparing part is reset. For substantial operation of the voltage/pulse converter, the first analog switch 110 turns off, which makes no more current flow to the charging part 11. Then, the second analog switch turns on and the fourth analog switch 122 turns off. If the voltage of the capacitor 111 is higher than the reference voltage, then the output of the voltage comparator 121 turns on, if not, then the output of the voltage comparator 121 turns off.

As shown in Fig.2A, when the output of the voltage comparator 12 turns on, the pulse extracting part 13 continuously generates pulses at a master clock cycle. The pulse output of the pulse extracting part 13 is returned back to the third analog switch 140 in the discharging part 14. With the result of it, the pulse output of the pulse extracting part 13 makes the third analog switch in the charge discharging part 14 turn on. The capacitor 111 is coupled to the discharge controlling part 141 and the current through the capacitor is discharged. Therefore, the voltage of the capacitor 111 becomes lower. The operation as described above continues until the voltage of the capacitor 111 is lower than the

reference voltage of the voltage comparator 121. Pulses are generated in the pulse extracting part 13 by tthistime.

As shown in Fig.2B, the output signal of the voltage comparator is provided to the pulse extracting part 13. The output signal of the voltage comparator is returned back to the discharging part 13. When the output signal is on state, the third analog switch 140 turns on, and also, the pulse extracting part 13 continues to output pulses at a master clock period. However, if the third switch 140 turns on, the capacitor is coupled to the discharge controlling part 141. The current through the capacitor is discharged. Therefore, the voltage of the capacitor becomes lower. The operation as described above continues until the voltage of the capacitor 111 is lower than the reference voltage of the voltage comparator 121. Pulses are generated in the pulse extracting part 13 by this time.

As described above, the discharging part 14 comprises the third analog switch 140 and the discharge controlling part 141. The third analog switch 140 turns on or off in response to the output of the voltage comparing part 12 or the pulse extracting part 13. When the third switch 140 turns on, the capacitor 111 is coupled to the discharge controlling part 141. Though the current through the capacitor 111 is discharged. Resistant elements or constant-current elements are used as the discharge controlling part 141.

The discharge controlling part 14 illustrated in Fig.3A and 3B use the resistant elements. In case that an n-type field effect transistor (MOSFET) is used, a gate and a drain are coupled to the

third analog switch 140, a source is grounded. This configuration has an advantage that an external signal does not effect on the discharge controlling part 14.

The discharge controlling part 14 illustrated in Fig.4A and 4B use the resistant elements. In case that an n-type field effect transistor (MOSFET) is used, a drain are coupled to the third analog switch 140, a source is grounded, and a gate is coupled to the outside. The gate can be controlled from the outside. This configuration has an advantage that discharge of the capacitor can be controlled by the external signal of the discharge controlling part 14.

The discharge controlling part 14 illustrated in Fig.5A and 5B use MOSFET resistant control type multiplier or analog control type multiplier. The discharge controlling part 14 is not effected from the external signal and can be controlled by its external signal.

If the voltage of the capacitor 111 in the charging part 11 becomes lower than the reference voltage V_1 of the voltage controlling part 12, the pulse extracting part 13 generates no more pulse. Then the voltage/pulse converting operation is completed. After the voltage/pulse converting operation is completed, to remove remain charges in the capacitor 111, the fifth analog switch 112 is made to turn on, thereby discharging all of current through the capacitor 111.

An embodiment of the voltage comparing part 121 will be described with reference to Fig.6.

The voltage comparing part 121 consists of a first p-type MOSFET 61, a second p-type MOSFET 62, a first n-type MOSFET 63 and a second n-type MOSFET 64. The source of the first p-type MOSFET 61 is coupled to Vpp. The source of the second p-type MOSFET 62 is coupled to Vpp, its gate is coupled to the gate of the first p-type MOSFET 62, and its drain is coupled to the output terminal. The drain of the first n-type MOSFET 63 is coupled to the gate and the drain of the first p-type MOSFET 61, its gate is coupled to V_, and its source is coupled to Vnn. The drain of the second n-type MOSFET 64 is coupled to output terminal, its gate is coupled to V+, and its source is coupled to Vnn.

If V_ is higher than V+, V_0 is a result value subtracted 1.1V from Vpp. In this case, since V_0 is almost equal to Vpp, V_0 becomes on. If not, V_0 is a result value added 1.1V to Vnn. In this case, since V_0 is almost equal to Vnn, V_0 becomes off.

Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.